HONG KONG ADVANCED LEVEL EXAMINATION
AL PHYSICS
1991 Essay Type Question

1. (a) Derive an expression for the kinetic energy of a body of mass *m*, and hence explain its meaning, by considering the body to be linearly accelerated from rest to a velocity *v*. (2 marks)

   (b) Show that an analogy exists for rotational motion and hence define the physical quantity 'moment of inertia'. (3 marks)

   (c) How would your differentiate experimentally between a hollow and a solid cylinder, which both have the same dimensions and mass? Give the theory of your method. (4 marks)

   (d) Describe, and give the theory of, an experiment to measure the moment of the inertia of a flywheel. (7 marks)

2. (a) Briefly distinguish between the different types of strongly attractive forces which bond atoms of materials together. (6 marks)

   (b) Taking into consideration the resistance of solids to deformation by external forces, sketch the expected variations of (1) the interatomic force and (2) the potential energy against the separation of two atoms in a solid. (4 marks)

   (c) (i) Sketch the expected variations of stress against strain for (1) a copper wire, (2) a rubber band and (3) a glass fibre in a Young modulus experiment, the loading being increased to just before the materials break.

   (ii) Briefly account for the different behaviour of the materials.

   (6 marks)

3. (a) By considering the propagation of light waves through slit(s), carefully distinguish between diffraction and interference. (7 marks)

   (b) Explain why interference of light is not observed when

   (i) two separate light sources are used and

   (ii) the path difference between light rays from the same light source is too great.

   (4 marks)

(c) Draw a diagram showing what you would expect to observe when viewing through a diffraction gating the vertical glowing filament of an electric lamp, placed several meters away. The grating is placed with its ruled lines parallel to the filament. Briefly explain the observations you make. (5 marks)

4. (a) An a.c. voltage supply is connected across a coil of many turns, this coil being placed over the vertical iron rod of a retort stand and resting on the base. Explain clearly your expected observations, and the physical principles involved when

(i) a small aluminium ring is dropped over and slides down the vertical rod of the retort stand,

(ii) the ring of (i) is replaced by a similar ring, but broken by a vertical slot and

(iii) the ring of (i) is fastened down on top of the coil.

(6 marks)

(b) A series circuit is formed from a coil of inductance 500 H, a 2 V light bulb, an open switch and a 2 V battery. Explain your expected observations when

(i) the switch is closed and

(ii) after connecting a neon lamp across the coil, the switch is opened.

(4 marks)

(c) Draw a circuit which can be used to observe the periodic variations of current I together with those of an applied a.c. voltage V for the coil of (b). Explain mathematically the phase difference you would expect between I and V.

(6 marks)

5. (a) Explain how you would distinguish experimentally between α, β and γ-radiating radioactive sources using a Geiger-muller counter detection system.

(6 marks)

(b) What changes take place in the constituents of the nuclei when such radiations are emitted? (3 marks)

(c) Explain your choice of type of radiation source, giving brief details of use for

(i) monitoring paper thickness, during manufacture,

(ii) estimating the size of nuclei and

(iii) treating body cancer by destroying cancer cells.

(7 marks)

6. (a) An initially uncharged capacitor of capacitance C is connected in series with a resistor of resistance R. The capacitor is now fully charged up by connecting a battery of e.m.f. E across this combination.

(i) Derive an equation $\frac{dQ}{dt} = A - BQ$, where Q is the charge stored in the capacitor after the battery has been connected for a time t. Determine the constants A and B in the above equation.

(ii) Solve this equation for Q and sketch the variation of Q with t. Give physical explanations of the variation.

(iii) From first principles determine the total work done by the battery in fully charging up C and the final energy stored in C. Explain, and account for mathematically, any difference between these.

(11 marks)

(b) (i) Write down an analogous equation to that of (a)(i) for the velocity v of a ball bearing of radius a and mass m falling vertically, from rest, in a viscous liquid after an elapsed time t. The effect of the buoyancy of the liquid should be neglected.

(ii) Solve the equation for v and sketch the variation of v with t. Give physical explanations of the variation.

(5 marks)

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